Dispersion of the Giant African Snail, *Achatina fulica*

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Dispersion of organisms is of specific interest to biologists and of general interest to others. One of the first questions asked concerning the discovery of the giant African snail *Achatina fulica* Bowdich, in Florida in 1969, concerned its dispersal. An account of this is given by Sturgeon (in press). Consideration of dispersion of the snail associated with distance from Africa is given here.

Movement of the giant African snail from its apparent origin into previously uninfested areas has required time. Such movement, or dispersion, had two barriers or hazards in addition to bodies of water; these were time and distance. Energy from within the snail, or from without by means of some agency, was necessary to effect dispersion. Time in greater or lesser amounts, however, is also required for energy to effect dispersion of other species of organisms. Relationships of time and distance were given for dispersion of the tsetse fly, *Glossina morsitans* Wst., by Jackson (1940); of a fruit fly, *Drosophila pseudoobscura* Duda by Dobzhansky and Wright (1943); of *Aedes albopictus* (Skuse) by Bennet and Worcester (1946); of a European corn borer parasite *Lydella stabulans grisescens* R. D. by Baker, et al. (1949) and of three species of flies, *Musca domestica* (L.), *Phaenieia sericata* (Meig) and *Phormia regina* (Meig), by Lindquist et al. (1951). Graphic studies of these data by Wolfenbarger (1959) showed relationships of time and distance in the dispersal of organisms. Much emphasis and considerable data were given by Mead (1961) on dispersal of the giant African snail as it was moved from country to country for over a century in a succession of movements. These data indicated rates of movement of the species from Africa to Hawaii. Consideration of these data and of the infestation in Florida are given here. By whatever means of dispersal utilized by the snail it appeared that a rate of movement could be determined where considerable data were available.

Factors Affecting Dispersion. Information on movement of the snail by man previous to about 1800 is lacking. Much purposeful movement of the giant African snail was made since then by man to islands and countries of the western Pacific and southeastern Asia, especially during the territorial expansion by the Japanese during the decade 1935-45. Exportations of snails were made for the purposes of raising food for man and as given also by Mead (1961), for barnyard fowls. Purposeful movement was made by man to Hawaii, according to Mead (1961), and to Florida, apparently for aesthetic reasons, as pets or as a novelty. Hitchhiking on or in articles of commerce, is also common with the giant African snail according to records of shipments from countries infested with the pest. Man appears, therefore, to be the primary agent of dispersal in all movements to other islands or distant countries. Bodies of water are barriers to snail dispersal. Crawling is the mode of snail movement on land. Such movement is slow although this phase of snail dispersion also has its rates of dispersal. Can crawling be termed the natural mode and transportation by man the unnatural mode of snail dispersion?

Methods or Procedure. Distances from Africa, in miles, were measured on a globe to the locations given by Mead (1961) and to Florida. Measurements were by means of a tape, made in a more or less direct line from the eastern coast west of Madagascar. The year of recognition of the snail in different countries listed by Mead (1961) and in Florida in 1969, and distances from Africa, were the variables employed in a regression study.

Approximations of distance are accepted in this study firstly because it is impossible to know the point of departure of the snails for a new invasion; secondly the point of arrival cannot be known exactly and thirdly the direction traveled was presumably over water in most instances and cannot be known. Many or most of the snails reported as sources of new infestations, were doubtless several to many generations after those originally from Africa. Furthermore, discovery of the species in newly infested areas may have occurred years after the introduction. Hence, although there are several sources contributing to error, the data give interesting statistical and biological considerations.

Results. Country infested, with year of snail introduction and expected from regression calculations are given in Table 1. Graphical studies of the records in terms of distances as related to the years through construction of a scatter diagram are given in Fig. 1. Plotting the data on uniform spaced grids indicated a curvilinear relationship which was made rectilinear by graphing them on semilogarithmic spacing. Conversion of the distance figures was made

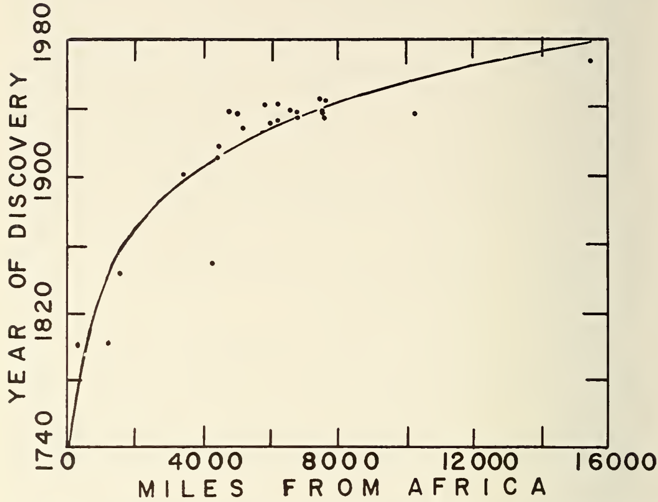

Fig. 1. Regression curve showing relationships of the giant African snail dispersal from the eastern African coast to lands eastward and northeastward years later.

to logarithms, in the manner developed by Wadley and Wolfenbarger (1944), for computation of a regression curve. This curve was drawn in Fig. 1 after reconversion of the logarithms to distance data.

The regression formula determined, following methods given by Snedecor (1956) was

$$\text{Expected year of infestation} = 1441.36 + 128.41 \ (\log X).$$

The regression coefficient was highly statistically significant, with a t value of 10.6; a highly significant coefficient of correlation was found with $r = 0.91$, and a chi-square test of the data in Table 1 showed a highly nonsignificant value of 7.24, with 23 df and gave further evidence for faith in the curve of Fig. 1.

Conclusions. Regression of the giant African snail on the year recognized in a locality continued from about 1800 to the present in an accumulative manner. Expected year of discovery was 1775

TABLE 1
Observed and calculated year of discovery of African giant snail

Locality	Observed year	Calculated year
Madagascar	1800	1775
Mauritius	1800	1839
Seychelles	1840	1853
Ceylon	1900	1896
India, Calcutta	1847	1908
Singapore	1917	1910
Malaya	1911	1910
Thailand	1937	1914
Vietnam	1937	1916
Sarawak	1928	1919
Hongkong	1941	1925
Amoy	1931	1927
Philippines	1942	1928
Formosa	1932	1928
North Borneo	1939	1932
Caroline Islands	1938	1934
Ryukyu Islands	1935	1934
Palau Islands	1938	1934
New Guinea	1945	1938
Bonin Islands	1938	1939
Mariana Islands	1937	1940
Japan	1933	1940
Bismarck Archipelago	1945	1940
Hawaii	1936	1956
Florida	1969	1979

at Madagascar instead of the observed 1800. Year of snail discovery and distance of the country from Africa were closely related.

Rather uniquely, the giant African snail has dispersed in an easterly direction. Latin American lands of Central and South America and of the Caribbean area apparently remain free of *Achatina fulica*. Low temperatures limit infestations of the temperate zones to areas bordering the torrid zones. Explanations for eastward dispersal appear somewhat conjectural but are suggested. Much of the nearer lands having temperature, moisture, and plants acceptable to the snail, are eastward from Africa. Less industrialization and more dependence on food producing areas near to the human consumers and requiring shorter transportation were doubtless factors favoring eastward dispersion. Greater frequency of man's transportation, and the apparently equal curiosity or aesthetic desires of peoples in all lands seem unlikely to explain the eastward movements. Japanese expansionary forces mentioned above doubtless aided and abetted untimely snail dispersion to a number of lands according to Mead (1961). Tropical and subtropical lands of the Caribbean, Central and South American countries may become infested with the giant African snail except as it is excluded.

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